Claims

1. Apparatus for simulating the deformation of materials, particularly of soft body tissues, comprising:

- a memory zone (MEM, MT) adapted to store, for at least one object:
  - mechanical parameters of the material of the object (λ, μ),
  - data as to the position of the object (Lj), recorded at the vertices (Sj) of at least one selected mesh (Tn), and
  - force data (F_j^n) which represent, in intensity and position, stress to be exerted on the object,
- and a computer (μP, MT) capable of co-operating with the memory zone (MEM) to evaluate new positions of the vertices (Sj), as a function of the stress exerted and the mechanical parameters of the material,

characterised in that the computer comprises:

- a module (12, 14, 16, 18, 20) adapted to determine repeatedly, for each mesh, the deviation between the current length (lj) of an edge of the mesh and its previous length and/or its length at rest (Lj), and to store respective force data (F_j^n) for each vertex of the mesh, and
- a module (30, 32, 36) adapted to determine repeatedly, for each vertex, new data as to the position of this vertex (Sj(Qn)) as a function of the composition of the forces exerted thereon (F_j^n), data relating to at least one previous position of the vertex (Sj(Tn)) and mechanical parameters of the material.

2. Apparatus according to claim 1, characterised in that for an object in the form of a hollow three-dimensional envelope the grid pattern chosen is triangular, so that the computer is able to determine the composition of forces at

each vertex of a triangle, as a function of the deviation between the current length of each side of the triangle and the length of this side at rest.

3. Apparatus according to one of claims 1 and 2, characterised in that, for an object of solid three-dimensional shape, the grid pattern chosen is tetrahedral, so that the computer is able to estimate the composition of the forces at each vertex of the tetrahedron, as a function of the deviation between the current length of each edge of the tetrahedron and the length of this edge at rest.

4. Apparatus according to one of the preceding claims, characterised in that the computer is adapted to determine differences between the squares of the current length (lj) and the preceding length and/or the length at rest (Lj) of each edge in order to determine said composition of forces.

5. Apparatus according to one of the preceding claims, characterised in that the memory zone is adapted to store, in association with each mesh, mechanical parameters of the material of the mesh (λ_n, μ_n), at least partially defined locally, particularly at the level of the mesh or elements thereof.

6. Apparatus according to claim 5, characterised in that the computer is adapted to determine said deviation between the current and at rest lengths, with a view to estimating a derivative of the potential deformation energy (*W*) of each mesh, expressed as a function of a Green-St Venant tensor (*E*) and of mechanical coefficients inherent in the material in said mesh.

7. Apparatus according to claim 6, characterised in that the mechanical parameters comprise the Lamé coefficients of

the material in each mesh in question (λ_n, μ_n).

8. Apparatus according to one of the preceding claims, characterised in that it comprises a module for developing a data structure and adapted to delete mesh sides or edges (Ai) which connect two so-called "virtual" vertices (Si).

9. Apparatus according to claim 8, characterised in that the module for developing the data structure is further adapted to verify that the grid pattern satisfies predefined properties of conformity.

10. Apparatus according to one of the preceding claims, characterised in that the module (30, 32, 36) adapted to determine the new positional data of the vertices (Q'n) as a function of the composition of forces at each vertex, is adapted to determine said new positional data as a function of time (E3), which makes it possible to follow the evolution of the respective positions of the vertices over time.

11. Apparatus according to claim 10, characterised in that the determination of the new positional data of the vertices (Q'n) uses a model for solving a differential equation applied to each vertex.

12. Apparatus according to one of the preceding claims, characterised in that the computer is capable of repeatedly determining the positional data of the vertices of the grid, with a view to determining the evolution of said positions over time ($t+\Delta t$).

13. Apparatus according to claim 12, characterised in that it comprises a display interface (VISU, IG) capable of representing the object in a predetermined form and shown

with the desired grid pattern, and in that the display interface is adapted to co-operate with the computer in order to display the shape of the moving object.

14. Apparatus according to one of the preceding claims, characterised in that it comprises a user interface (IU) provided with a handling device (CLA, MO) for simulating one or more forces exerted globally on the object.